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Determining variable importance on electrodialytic remediation of heavy metals from polluted harbour sediments

Kristine B. Pedersen[a,*], Lisbeth M. Ottosen[b], Pernille E. Jensenb, Tore Lejon [a]

[a] *Department of Chemistry, The Arctic University of Norway, 9019 Tromsø, Norway*
[b] *Arctic Engineering and Sustainable Solutions, Technical University of Denmark, 2800 Kgs Lyngby, Denmark*
**Corresponding author: kristine.b.pedersen@uit.no*

Harbour sediments have been exposed to a wide variety of pollutants caused by decades of human activities in the harbours as well as on adjacent land. The need for management of polluted harbour sediments arises either through governmental acts to decrease the hazardous risk for human health and the environment; or through the development of harbours in which contact with or removal of polluted sediments is inevitable; e.g. when increasing navigational depths. The most common way of dealing with dredged contaminated sediments is disposal at licensed landfills (on land or at deep sea), and in some cases solidification/stabilisation of the sediments, e.g. in new harbour constructions. In order to increase the recycling potential of contaminated sediments there is a need to develop more cost-efficient methods for remediating to levels at which the sediments are made available for reuse. Electrodialytic remediation (EDR) has been proven a good method for removing heavy metals from polluted harbour sediments to levels assessed as not posing a hazardous risk for human health and the environment according to international recommended values from OSPAR [1-7].

The focus of this study was to contribute to the further development and optimisation of the EDR methods in remediating harbour sediments, applying the newly developed two compartment cells as opposed to the traditional three compartment EDR cells. In the traditional three compartment cells ion exchange membranes separate the sediment in suspension from the electrodes and the circulating electrolytes to prevent proton and hydroxyl ions produced at the electrodes from entering the polluted material[8]. Water splitting at the anion exchange membrane ensures acidification of the polluted material. In the two compartment cells the anode is placed directly in the polluted material compartment; maintaining the separation of the cathode from the sediment in suspension by a cathode exchange membrane thus preventing the hydroxyl ions produced at the cathode from disturbing the remediation process in the sediment compartment.

The influence and relative importance of the experimental variables (current density, remediation time, stirring rate of the sediment in suspension, liquid-solid ratio of the suspended sediment and light/no light) on the remediation of the heavy metals cadmium, chromium, nickel, copper, lead and zinc from polluted harbour sediments from Sisimiut in Greenland was tested. Measurements of the metals aluminium, barium, calcium, iron, potassium, magnesium, manganese, sodium and vanadium were made as indicators of the changes EDR may have on the sediment matrix.

A multivariate statistical experimental design was applied ensuring that as much as the experimental space was covered in the 8 experiments and in addition enabled the

multivariate analysis of the results for assessing the relative variable importance. This was done by performing projection to latent structures (PLS) in which relations between two matrices; a X matrix with independent experimental variables and a Y matrix with the responses (i.e. remediation levels) was determined. The PLS analysis hence assess the possible relation between the variation in the experimental variables and the variation in the remediation levels. Results of the PLS analysis indicate the order of relative variable importance as time>current density>>stirring rate>liquid-solid ratio>light. For the given experimental design the most important variables for the remediation process is time and current density.

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